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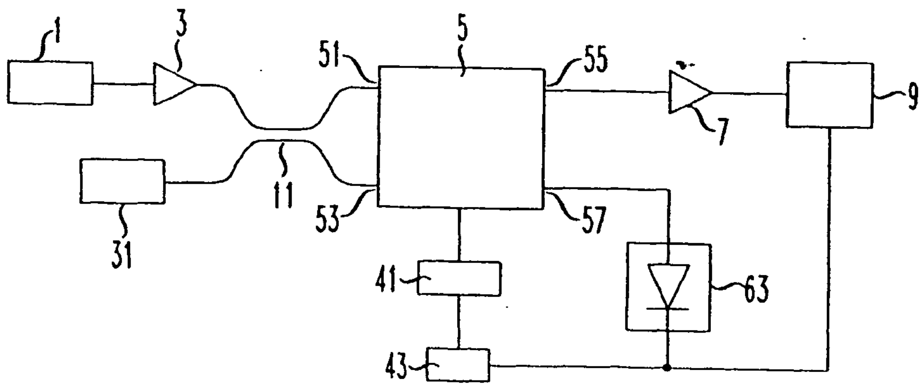
(54) **Optical communication system using tandem Fabry-Perot etalon for wavelength selection**

(57) A tunable tandem Fabry-Perot etalon (5) is used in wavelength division multiplexed optical systems or in an optical device. One path is used to calibrate the pre-spectral range with respect to a reference wavelength and the other path is used to select and acquire the desired wavelength.

FIG. 1



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the exemplary embodiment of the invention depicted in FIG. 1. It will be readily appreciated that, for reason of clarity, the elements depicted are not drawn to scale. Shown are transmitter 1, preamplifier 3, tunable tandem Fabry-Perot(FP) filter 5, amplifier 7, and receiver 9. A multiplexer 11 is connected to the preamplifier 3. There is a source of a reference wavelength 31 and a photodetector 63. Optical fibers connect the transmitter to the preamplifier and the amplifier to the receiver. Optical coupling means, such as optical fibers or other waveguides, couple the source 31 and photodetector 63 to the filter 5. Filter 5 has first and second inputs 51 and 53 and first and second outputs 55 and 57. There are two optical paths through the filter; the paths are between input 51 and output 55 and between input 53 and output 57, respectively. The first and second inputs are connected to the two output ports of the multiplexer 11. An input port of multiplexer 11 is connected to preamplifier 3. The first and second output ports are connected to the amplifier 7 and to the photodetector 63, respectively. Voltage source 41 is connected to photodetector 63 through digital processor 43. Varying the voltage from source 41 tunes both paths through the filter simultaneously. There is also a connection between the receiver 9 and digital processor 43. Elements are described as being coupled to each other; this terminology is used to mean optical coupling and does not preclude the presence of intermediate elements. Filter 5 may also be referred as an etalon.

Several types of sources may be used for the reference wavelength. For example, a semiconductor laser may be used. Alternatively, a fiber ring laser or a fiber grating laser may be used. Still other types can be used.

All of these elements are well known to those skilled in art and will be readily connected together by those skilled in the art. For example, the components of both transmitter 1 and receiver 9 are well known as are the optical fibers or other optical waveguides and to optically couple the elements described. Fabrication of the Fabry-Perot etalon is well known and its operation is described in literature for commercially available tunable etalons. See TB2500 Tunable Fabry-Perot Filter, JDS-Fitel. Tuning is expediently performed by changing the applied voltage to the filter 5; other techniques could be used.

Operation of the embodiment described, as well as the operation of the optical device is now readily understood. The reference wavelength is used to calibrate the system. The different free spectral ranges are measured versus voltage. In addition to the various types of sources previously mentioned, it is noted that the reference wavelength may come from either a local or a remote source located at, for example, a receiver or transmitter. The reference wavelength is extracted with the demultiplexer 11 located before the Fabry-Perot etalon. If the reference wavelength is located locally, the multiplexer 11 may be omitted.

FIG. 2 is useful in explaining how the desired signal is extracted and how the system locks onto the desired signal. Depicted are three free spectral ranges horizontally in arbitrary wavelength units and the amplitude of the reference wavelength vertically in arbitrary units.

The system or device is calibrated as follows. The system must be calibrated before signal acquisition. Calibration is the process of identifying the reference wavelength signal in terms of the FP tuning voltage (FP-TV) and locating the FPTV for the centermost FSR. It is desirable to identify two adjacent references modes as close to the center of the FP voltage sweep range as possible. This is FSR2 in FIG. 2.

The calibration process may be either active or passive. With active calibration, the system calibrates when power is turned on. The FP tuning voltage 41 sweeps through the complete tuning range and stores in memory the voltages at which the reference wavelength is detected by photodetector 63. These voltages are processed by digital processor 43 to determine the position of FSR2 in terms of the FP tuning voltage. When the position of FSR2 in terms of FP tuning voltage is known, the FP tuning voltage for a specific wavelength can be determined. This technique suffers a drawback when a new channel is to be detected and the temperature has changed since the last scan. The new channel may not be at the calculated position and the system may lock onto the wrong channel. A new scan should be performed every time the channel is changed. However, manufacturing costs are saved as no pretuning is required at the time of manufacture.

With passive calibration, the FP filter is calibrated during manufacture. The objective of this calibration process is identical to that in the active case; that is, locate the centermost FSR. However, data is also collected as the temperature is varied. The data are analyzed and a temperature versus FSR position is obtained. The resulting data are stored in memory either as a look up table or as coefficients used in calculating the channel location as a function of temperature. The temperature has to be measured by, for example, an element of the device (not shown) to determine the temperature dependence of the FP tuning voltage for a desired wavelength channel. From the temperature and the wavelength of the desired channel, the FP tuning voltage can be calculated or obtained from a look up table. There is increased cost during manufacture, but the system is easily made and channels can be changed without removing the system from service.

The position of the FPTV for a locked signal or wavelength is an important consideration and should be taken into account so that the desired wavelength can be accurately tracked as systems parameters, such as temperature, vary. Positioning the FPTV as close as possible to the centermost free spectral range gives the widest locking range; that is, the FPTV dynamic tuning range is optimized. Additionally, if lock is lost, the system can determine whether the signal has drifted in its wave-

12. An optical communications system as recited in claim 9 in which said digital processor further comprises memory for storing tuning voltages for wavelengths.

13. An optical communications system as recited in claim 12 in which said digital processor further comprises memory for storing tuning voltages for temperatures.

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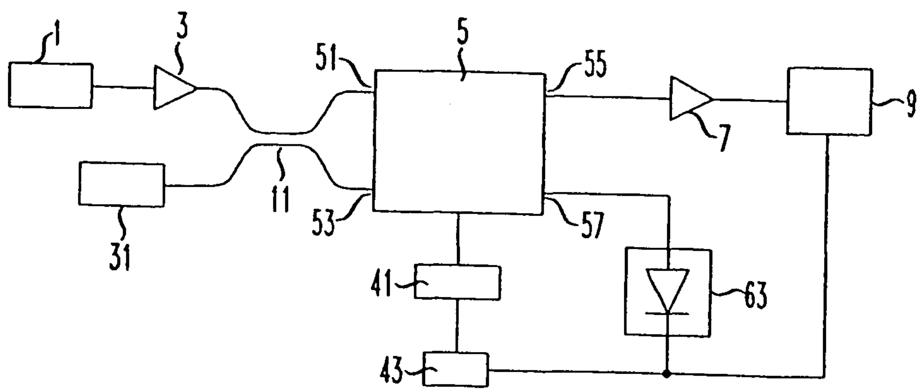

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 96 30 7800

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17-03-2000

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